Claims

1. A faceted polyhedron molecule or a polymeric structure comprising polygon moieties and linking moieties, wherein said polygon moieties comprise edges and vertices, wherein a first polygon moiety is attached to a second polygon moiety by at least one of said linking moieties, and wherein said at least one linking moiety is attached to a vertex of said first polygon moiety and a vertex of said second polygon moiety.

2. The faceted polyhedron molecule or polymeric structure of claim 1, wherein said at least one linking moiety is a coordinating ligand or a bridging ligand.

3. The faceted polyhedron molecule or polymeric structure of claim 2, wherein said first polygon moiety and said second polygon moiety each comprise a metal, and wherein said linking moiety is a coordinating ligand.

4. The faceted polyhedron molecule or polymeric structure of claim 3, wherein said coordinating ligand is attached to said vertex of said first polygon moiety and said vertex of said second polygon moiety through covalent interactions.

5. The faceted polyhedron molecule or polymeric structure of claim 3, wherein said coordinating ligand is a multifunctional carboxylate ligand.

6. The faceted polyhedron molecule or polymeric structure of claim 5, wherein said multifunctional carboxylate ligand is a bifunctional carboxylate ligand.

7. The faceted polyhedron molecule or polymeric structure of claim 6, wherein said bifunctional carboxylate ligand is benzene-1,3-dicarboxylate.

8. The polymeric structure of claim 1, wherein said linking moiety is a trifunctional carboxylate ligand.

9. The polymeric structure of claim 8, wherein said trifunctional carboxylate ligand is 1,3,5-benzene tricarboxylate.

10. The faceted polyhedron molecule or polymeric structure of claim 2, wherein at least one of said first and second polygon moieties comprises a non-metal moiety and said linking moiety is a bridging ligand.

11. The faceted polyhedron molecule or polymeric structure of claim 10, wherein said bridging ligand is a multifunctional molecular moiety capable of sustaining multiple supramolecular interaction.

12. The faceted polyhedron molecule or polymeric structure of claim 1, wherein said linking moiety subtends an angle of about 90° between the planes occupied by said first and second polygon moieties.

13. The polymeric structure of claim 1, wherein said linking moiety subtends an angle greater than about 90° between the planes occupied by said first and second polygon moieties.

14. The faceted polyhedron molecule or polymeric structure of claim 1, wherein said linking moiety subtends an angle of about 120° between the planes occupied by said first and second polygon moieties.

15. The faceted polyhedron molecule or polymeric structure of claim 1, wherein said linking moiety subtends an angle of about 144° between the planes occupied by said first and second polygon moieties.

16. The faceted polyhedron molecule or polymeric structure of claim 1, wherein at least one of said first and second polygon moieties comprises a non-metal.

17. The faceted polyhedron molecule or polymeric structure of claim 1, wherein said first or second polygon moiety can sustain 3-fold rotational symmetry.

18. The faceted polyhedron molecule or polymeric structure of claim 1, wherein said first or second polygon moiety can sustain 4-fold rotational symmetry.

19. The faceted polyhedron molecule or polymeric structure of claim 1, wherein at least one of said first and second polygon moieties comprises a transition metal.

20. The faceted polyhedron molecule or polymeric structure of claim 19, wherein said transition metal is in a 2+ transition state.

21. The faceted polyhedron molecule or polymeric structure of claim 19, wherein said first and said second polygon moieties each comprise transition metals.

22. The faceted polyhedron molecule or polymeric structure of claim 19, wherein said first and second polygon moieties each comprise transition metals, and wherein said transition metals are not in the same transition state.

23. The faceted polyhedron molecule or polymeric structure of claim 18, wherein said transition metal is not in a 2+ transition state, and wherein said faceted polyhedron molecule further comprises a counterion that may or may not be coordinated to said transition metal.

24. The faceted polyhedron molecule or polymeric structure of claim 1, further comprising a solvent molecule.

25. The faceted polyhedron molecule or polymeric structure of claim 1, further comprising a solvent molecule selected from the group consisting of methanol, ethanol, I-propanol, dimethylformamide, and acetonitrile.

26. The faceted polyhedron molecule or polymeric structure of claim 1, wherein said first polygon moiety comprises a non-metal and said second polygon moiety comprises a non-metal.

27. The faceted polyhedron molecule or polymeric structure of claim 26, wherein said first polygon moiety comprises a non-metal and second polygon moiety comprises a non-metal, wherein the vertices of said first and second polygon moieties are connected by a bridging ligand.

28. A compound comprising a faceted polyhedron molecule or polymeric structure, wherein said faceted polyhedron molecule or polymeric structure comprises polygon moieties and linking moieties, wherein said polygon moieties comprise edges and vertices, wherein a first polygon moiety is attached to a second polygon moiety by at least one of said linking moieties, and wherein said at least one linking moiety is attached to a vertex of said first polygon moiety and a vertex of said second polygon moiety.

29. A method of making a faceted polyhedron molecule or polymeric structure, wherein said method comprises contacting a first polygon moiety with a linking moiety and a second polygon moiety, wherein said linking moiety and said second polygon moiety are in solution, and allowing said solution to crystallize, forming the faceted polyhedron molecule or polymeric structure.

30. The method according to claim 29, wherein said at least one linking moiety is a coordinating ligand or a bridging ligand.

31. The method according to claim 29, wherein said first polygon moiety comprises a metal and said second polygon moiety comprises a metal, and wherein said linking moiety is a coordinating ligand.

32. The method according to claim 31, wherein said coordinating ligand is attached to said vertex of said first polygon moiety and said vertex of said second polygon moiety through covalent interactions.

33. The method according to claim 31, wherein said coordinating ligand is a multifunctional carboxylate ligand.

34. The method according to claim 33, wherein said multifunctional carboxylate ligand is a bifunctional carboxylate ligand.

35. The method according to claim 34, wherein said bifunctional carboxylate ligand is benzene-1,3-dicarboxylate.

36. The method according to claim 33, wherein said multifunctional carboxylate ligand is a trifunctional carboxylate ligand.

37. The method according to claim 36, wherein said trifunctional carboxylate ligand is 1,3,5-benzene tricarboxylate.

38. The method according to claim 29, wherein at least one of said first and second polygon moieties comprises a non-metal moiety and said linking moiety is a bridging ligand.

39. The method according to claim 38, wherein said bridging ligand is a multifunctional molecular moiety capable of sustaining multiple supramolecular interaction.

40. The method according to claim 29, wherein said linking moiety subtends an angle of about 90° between the planes occupied by said first and second polygon moieties.

41. The method according to claim 29, wherein said linking moiety subtends an angle equal to or greater than about 90° between the planes occupied by said first and second polygon moieties.

42. The method according to claim 29, wherein said linking moiety subtends an angle of about 120° between the planes occupied by said first and second polygon moieties.

43. The method according to claim 29, wherein said linking moiety subtends an angle of about 144° between the planes occupied by said first and second polygon moieties.

44. The method according to claim 29, wherein said first polygon moiety comprises a non-metal and said second polygon moiety comprises a non-metal, and wherein said linking moiety is a bridging ligand.

45. The method according to claim 29, wherein said first or second polygon moiety can sustain 3-fold rotational symmetry.

46. The method according to claim 29, wherein said first or second polygon moiety can sustain 4-fold rotational symmetry.

47. The method according to claim 29, wherein at least one of said first and second polygon moieties comprises a transition metal.

48. The method according to claim 47, wherein said transition metal is in a 2+ transition state.

49. The method according to claim 47, wherein said first and said second polygon moieties each comprise transition metals.

50. The method according to claim 49, wherein said first and second polygon moieties each comprise transition metals, and wherein said transition metals are not in the same transition state.

51. The method according to claim 47, wherein said transition metal is not in a 2+ transition state, and wherein said faceted polyhedron molecule further comprises a counterion that may or may not be coordinated to said transition metal.

52. The method according to claim 29, further comprising contacting a solvent molecule with said solution before crystallization.

53. The method according to claim 52, further comprising a solvent molecule selected from the group consisting of methanol, ethanol, I-propanol, dimethylformamide, and acetonitrile.